Atomically Engineered Silicon and Sapphire Substrates

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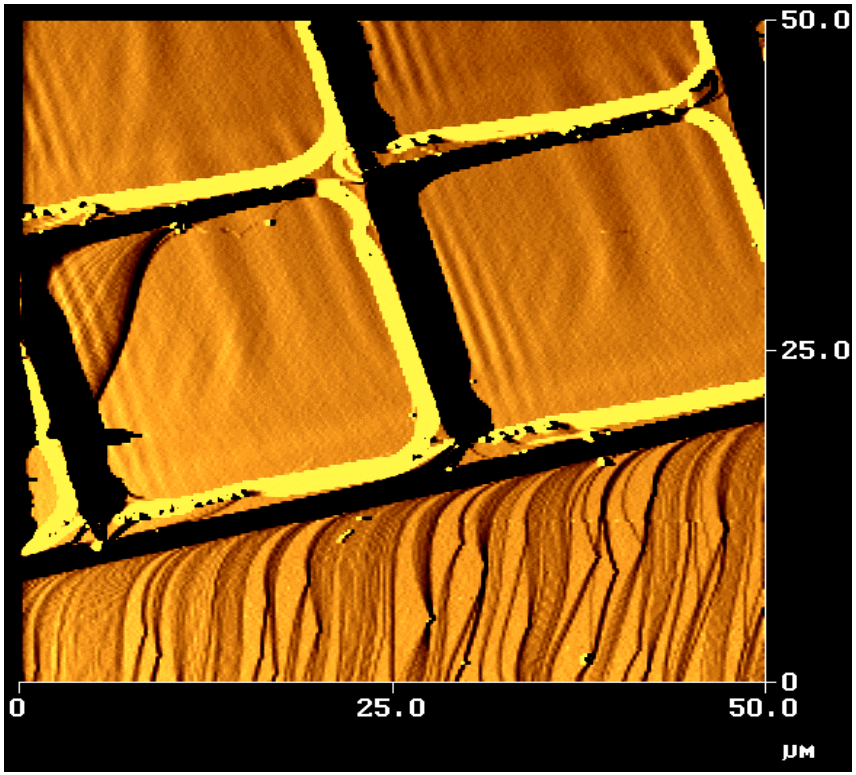
Single crystal substrates are used in a wide variety of materials processing of electronics, biosensors and magnetic devices. Silicon-silicon dioxide surfaces are of prime importance in the development of the smallest fastest transistors for computer processors. In current devices the gate oxide is only of the order of a few atomic spacings. One way to improve performance is to create the devices on atomically smooth surfaces. This project has developed methods to make this possible. Wafers have been processed to have arrays of atomically smooth regions on which devices can be located. Areas with predetermined atomic step arrays can also be designed as templates for attachment of bio- and other molecules.



Portion of a Si wafer surface that has been processed to have arrays of atomically flat 20 x 20 micron regions. The lower portion shows normal unprocessed Si surface with numerous atomic steps. AFM image

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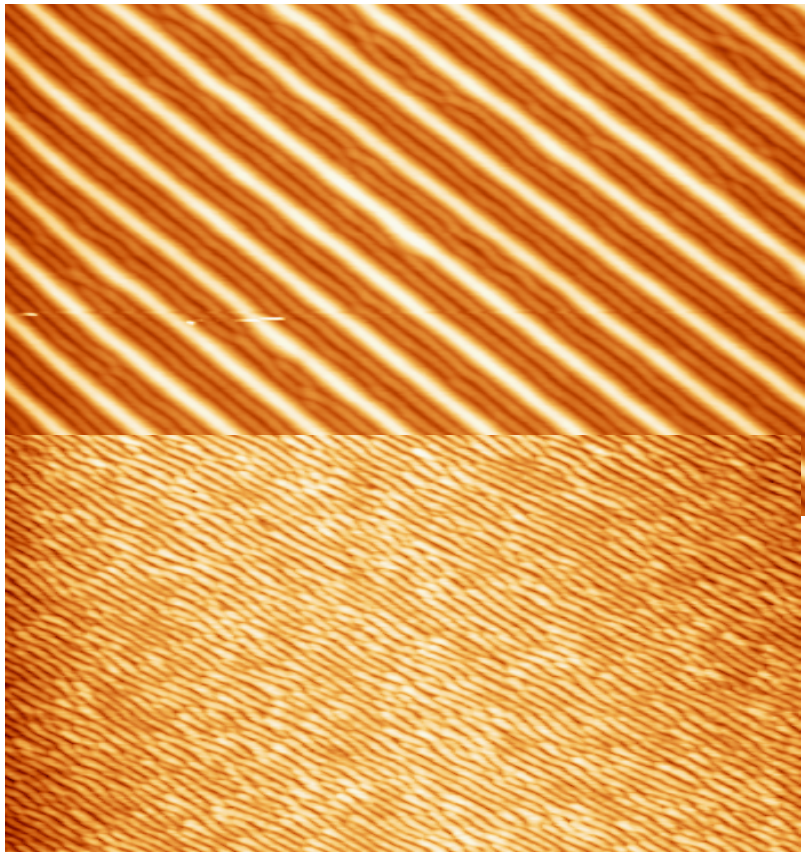
A Related Undergraduate Project

Through a collaboration with the research group of Professor M. Aziz at Harvard it has been demonstrated that patterned surfaces of Si develop well ordered morphologies when bombarded with ion beams in the several 100 eV range.. This is illustrated in the figure.

At Cornell two undergraduates are pursuing the corresponding effect on SiO_2 surfaces and on glass wafers.

This project is of interest in the texturing of display glass surfaces but is also a promising technique to make large areas of SiO_2 (the substrate in most bio-sensor work) that are patterned with features in the 30nm range.



Atomic force microscope images of Si surfaces ion bombarded at glancing incidence. Top image shows very regular 'ripples' induced by surface patterning while the bottom image shows a considerably less ordered surface in the unpatterned case. Images are 8 microns wide.